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Contents :

CAST IRON AND ITS RELATION TO MACHINE TOOLS

by P. A. Russell, B.Sc.

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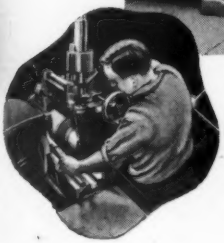

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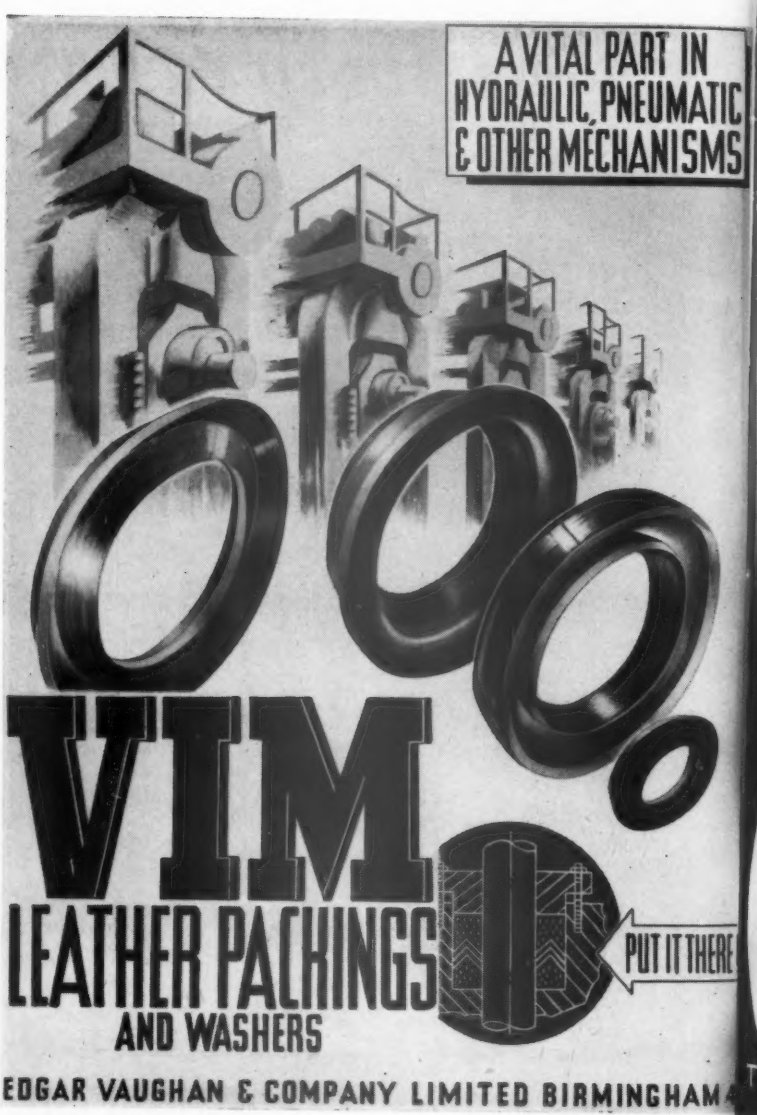
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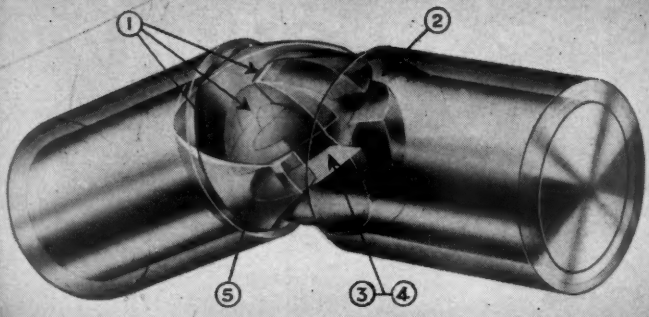

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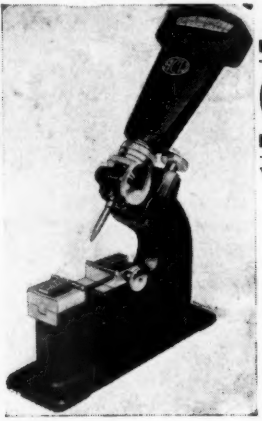

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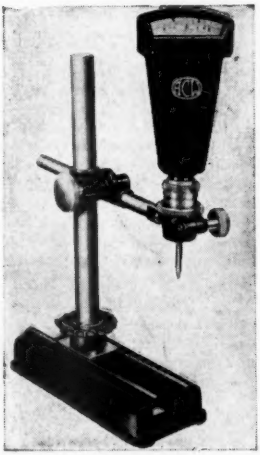

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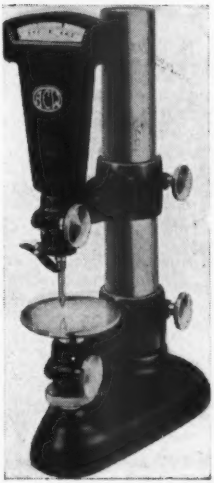

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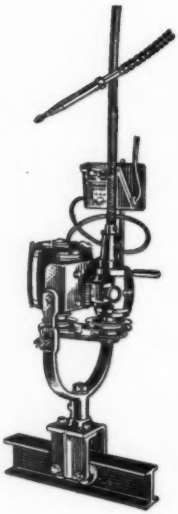

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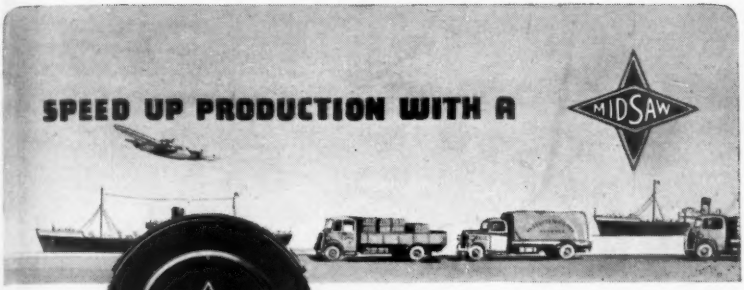

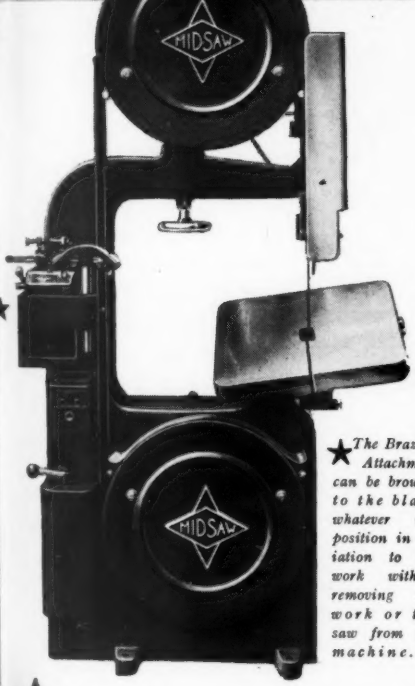

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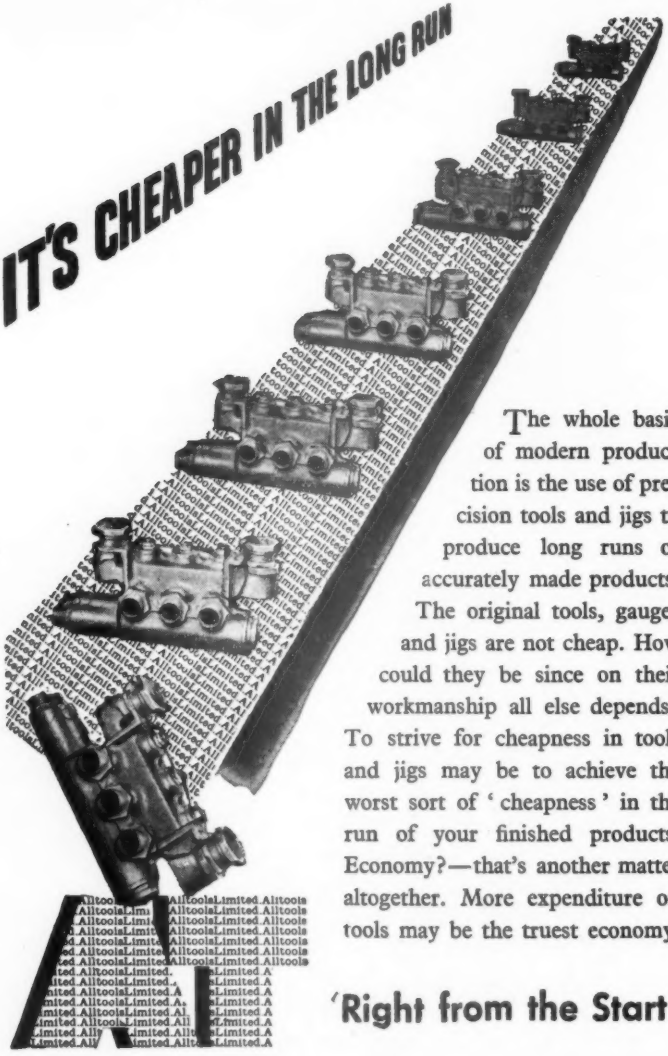

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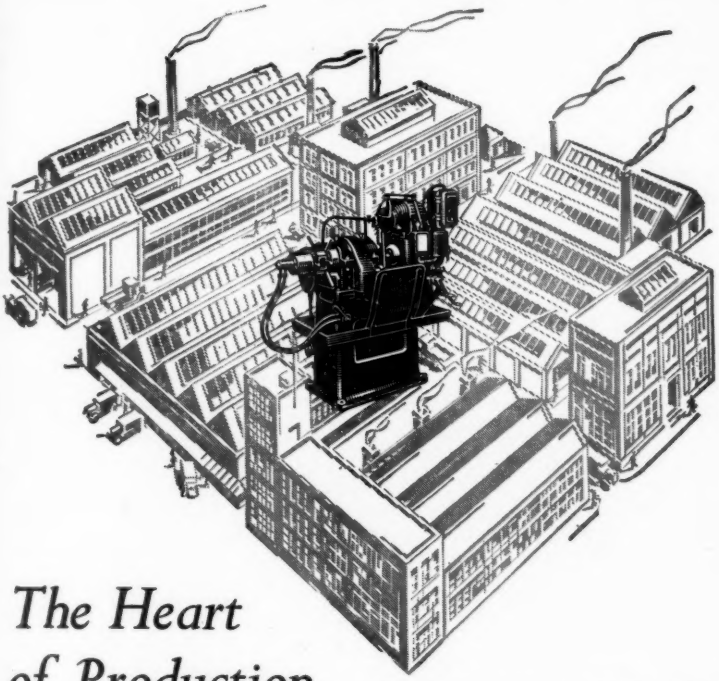

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CAST IRON AND ITS RELATION TO MACHINE TOOLS

By P. A. RUSSELL, B.Sc.,
of S. Russell & Sons, Ltd., Leicester

Presented to the Derby Sub-Section of the Institution of Production Engineers, 15th January, 1945

This paper is largely a repetition of a paper of the same title given to the Leicester Section of your Institution in November 1939, but I have rather expanded the metallurgical points at the beginning of the paper and introduced a few new items and illustrations.

I am always uncertain, when talking to a meeting of Engineers, how much metallurgical knowledge I can assume you have. I am very anxious for you to have a clear knowledge of the nature of cast iron, and I offer no apology for attempting to state the metallurgy of Cast Iron in its simplest form.

Ordinary Cast Iron can be regarded as steel broken up by flakes of Carbon, called Graphite, but this steel may be of any quality from the almost carbon free dead mild type, through the strongest or fully pearlitic type with Carbon about ·8%, to the hardest Cast Steel type containing free Iron Carbide. This latter may be present in large quantities, and is the major constituent of hard white iron.

There is one other major constituent in Cast Iron—Phosphorus, which may be present in amounts from ·1-1·7%. This forms a complex eutectic with Iron and Carbon, which is 10-15 times the quantity of the phosphorus. This is a hard and brittle substance which has a good deal of importance from the point of view of strength, wear resistance and hardness.

Up to about 1914 it was the object of every maker of machinery castings to produce a Cast Iron suitable for the plain carbon steel cutting tools then in use, so that Iron with a maximum amount of its carbon in the graphite form and the matrix as near Mild steel as possible, was produced. This had a tensile strength rarely exceeding 10-tons sq. in.

Then, with the introduction of High Speed Steel, harder forms of cast iron could be machined, and it became the object of founders to produce an iron with a pearlitic matrix, which gave an all round improvement in properties, the tensile strength increasing to about 15-tons sq. in. The most notable example of this was the " Semi-steel " which was so popular shortly after the last war.

Then further improvement in the strength of the matrix was effected by use of alloys, particularly Nickel and Chromium, improving the tensile strength up to 18-tons sq. in.

It was realised that the lower the free or Graphite Carbon, which has no tensile strength, the stronger the iron, but it was found that, if this reduction was carried below a certain limit, the iron became brittle. This was found to be due to the carbon flakes all falling in one plane in low carbon irons, and it was found that this could be regulated by a process, generally known as Inoculation, and by this means unalloyed irons are now regularly produced with strengths up to 20-tons sq. in. and alloyed irons up to 25-tons sq. in.

Thus we see that there is a wide range of cast iron available.

After this preliminary metallurgical explanation, I will turn to the main subject of the evening—Cast Iron and its Relation to Machine Tools, and I am going to take full advantage of the title and treat the subject under two distinct headings :

1. Cast Iron as a material for the construction of Machine Tools.
2. The working of cast iron upon Machine Tools.

Cast Iron as a Material for the Construction of Machine Tools.

Cast Iron is the traditional material for the main constructional parts of machine tools for the following reasons : (1) Base of casting into fairly intricate shapes ; (2) low cost, compared to other materials ; (3) rigidity ; (4) reasonable resistance to wear, including its self-lubricating property owing to the presence of graphite and the penetration of oil into the graphite.

The introduction of high-speed tool steels, and still more the introduction of tungsten carbide tools, has created a whole new set of problems in machine tool design. These can only be met in part by the alteration of design and improvement in materials. I, therefore, propose to discuss the physical properties of cast iron from the point of view of machine tool construction.

Strength and Rigidity.

Ultimate tensile strength is of little importance in most machines as the sections required to obtain a rigid machine are such that failure by fracture is rare except in accidental cases. The designer tries to keep his major stresses in cast iron compressive, but bending stresses are bound to occur. Thus, the ordinary transverse test as used for cast iron may be a more useful guide than the tensile test.

So much depends, however, in cast iron upon the tensile strength that I must discuss this first. Improvements in this property of cast iron have kept pace with the demands of machine tools. The old figure of 9 to 11 tons tensile which is quoted in most text books is out of date so far as machine tool irons are concerned. This is not so much because the demand has been for stronger irons as because

of the demand for sounder irons which has resulted in an incidental increase in strength.

TABLE 1—MACHINE TOOL IRONS

Class of Cast Iron	Tensile tons Sq. in.	Tran'se R.S. tons Sq. in.	Brinell hardn's	Impact Ft. lbs.	Relative machinability
Light for guards	10	23	210	5	.08
Normal grade	14	30	220	7	.08
Special grade	18	33	230	9	.07
Ni-tensile	22	36	250	9	.07
Ni-tensile heat treated	28	36	320	9	.06
Ni-tensile + .5 Mo.H.Tr.	31	44	350	10	.04

Notes on Table 1.

Brinell hardness, 3,000 kg. load 10 m.m. ball. Impact, on special B.C.I.R.A. machine using unnotched bar, single blow. Bar 0.798 in. dia. Striking height, 1·3 in. Machinability, penetration inches per 100 revs. of Ardalloy tipped drill ½ in. dia. under 51-lb. load, tested on special A. Herbert machine.

It is now reasonable to demand that the iron for good machine tools should meet Grade I of B.S.S. 786 for high-duty cast iron, giving a range of 12½ to 15 tons per sq. in. tensile over the various sectional thicknesses. For the highest quality tools Grade II with tensile strength of 15 to 18 tons per sq. in. can fairly easily be met and should be sufficient to meet every demand except for parts carrying exceptional stresses. A third grade with tensiles of 18 to 20 tons per sq. in. is available for these cases in certain special types of cast iron such as Ni-tensyl or the higher grades of Mechanite. Even higher strengths can be obtained by heat treating these materials. A typical range of machine tool irons with their physical properties is given in Table 1.

Much more important than tensile strength is the modulus of elasticity—i.e., the amount of "spring." Shaw describes "every machine tool a bundle of springs."

The modulus of elasticity of the material plays a great part in rigidity, the higher the modulus the less the deflection under a given load. For example, an iron having a modulus of elasticity of 20×10^6 will extend 1/1000th of an inch on a bar 10 in. long under a load of 2,000 lb., whilst one with a modulus of 10×10^6 will extend the same amount under half this load.

The modulus of elasticity in cast iron increases approximately as the tensile strength increases. Thus the tensile strength may be a

useful guide. But the modulus does not increase in direct proportion to the tensile strength, and rises from 11×10^6 for the weakest irons to about 20×10^6 for the stronger irons. In the higher strength irons the modulus varies considerably and irons developed particularly for tensile strength do not necessarily have the best modulus of elasticity values.

Whilst the modulus of elasticity has been increased so that demands may be met, this increase has tended to reduce the capacity of cast iron for damping out vibrations. Damping capacity is an important factor about which very little is known. Ordinary soft cast iron has a very good damping capacity whilst steel is poor. This is one of the major reasons why fabricated steel is not favoured for machine tools.

Such evidence as is available shows that the damping capacity of cast iron decreases as the tensile strength and modulus of elasticity increase. Thus, to obtain the rigidity necessary for the production of fine finish on parts being tooled, it is necessary to effect a compromise between the benefits obtained by a high modulus of elasticity and the corresponding increase in tendency to vibration. The presence of graphite seems to give cast iron its good damping capacity and this is one of the reasons why a very low graphite content is not desirable.

Impact Strength.

This is not a property of great importance in most machine tool design, except from the point of view of accidental breakage. It is, however, of general interest and worth mentioning here.

No true cast iron is ductile, but cast irons vary greatly within themselves as to their resistance to sudden shock. During the war a recommended procedure for impact testing has been issued, which may become a standard. This is based on the ordinary Izod test, but using an unnotched specimen ·798 in. dia. The range of strengths normally to be obtained in this test are given in the table.

Resistance to Wear.

The other factor which the speeding up of machine tools has brought into the forefront is resistance to wear. Increased speeds and frequency of motion, combined with increased demand for accuracy have made this property of the utmost importance. Unfortunately resistance to wear is one of the most difficult things to measure as so many factors are variable. I will instance a few: (1) Lubrication ; (2) pressures ; (3) speeds ; (4) nature of opposing materials.

As previously stated, cast iron is reasonably good for resistance to wear of the type met with in the sliding parts of machine tools, owing to its being in fact a fairly high carbon steel broken up by

graphite flakes. The graphite flakes act as a lubricant and a reservoir for the absorbtion of oil. The improvement in cast irons already noted have largely contributed to resistance to wear, particularly the improvement brought about by the change from the old soft type of cast iron to the harder "semi-steel" type, which really consists of the raising of the base of the cast iron from a mild steel to a high carbon steel, accompanied by a reduction in the size and quantity of graphite flakes. I am not convinced that the engineer's desire for a cast iron which has so little graphite that it is scarcely visible is really to the best advantage from the point of view of wear. Certainly, in the immediate post-war period, the reduction in graphite size and quantity indicated an improvement in quality, but this can be carried too far, and good wear-resisting iron should not be too low in graphite.

The improvements in wear resistance offered by the normal improvements in cast iron are not sufficient, however, to meet the demands for the most exacting machines and further methods were evolved. One of the first of these was the densening of the important faces of the casting by placing in the mould an iron densener which increases the cooling rate of the metal, thus causing, locally, a higher combined carbon (i.e., a higher carbon in the steel groundwork) and a lower graphite content. This also enabled closer grained hard-wearing surfaces to be obtained on the "ways" of the casting than could normally be obtained. This is owing to the fact that these "ways" are usually of much heavier section than the rest of a casting, and the use of an iron to get the correct structure in these parts results in an unmachinable iron in the thinner parts.

Densening is still largely employed, and, provided that it is used intelligently and that the quality of the iron used is good and strictly controlled, it will meet the demands of the very largest proportion of machine tools. Objections are frequently raised that the use of denseners puts strains into a casting, which are relieved on machining, causing ultimate warpage. But it is my opinion that, provided that drastic densening is not necessary owing to the use of a poor quality iron, densened castings warp less than undensened ones. The chief cause of warping in castings is the unequal rate of cooling of thick and thin parts, and if the cooling of the thick part is accelerated by densening, so that it more nearly approaches that of the thin parts, it is natural to assume that warpage will be reduced.

I have carefully used the word "densener" instead of "chill" although the latter is the word commonly used. A chill, strictly speaking, is a piece of iron cast against the mould of sufficient bulk to accelerate the cooling of the iron so drastically that the iron becomes white and unmachinable. Such an iron is very hard and resistant to abrasive wear but is not really suitable for machine tools, although attempts have been made to use it. Machining and

warping problems are acute. The border line between densener and chill is very fine, and the foundryman who uses a densener that is just a little too heavy for the class of iron being poured, very soon finds himself in trouble with the machine shop owing to the appearance of hard spots and patches.

The next development in improving the wear of cast iron was by the use of alloying elements, particularly nickel and chromium. These alloys have two main effects when used in small quantities, and in the right proportions: (1) they raise the hardness of the steel groundwork and thus give extra resistance to wear; (2) they even up the structure of the casting so that it is possible to use an iron which is initially harder without the risk of the formation of hard spots in the thinner sections.

The use of these irons (Ni 1·0 to 2·0%, Cr ·3 to ·6%) certainly improves the wear resistance of the iron considerably, but the objection to their use is in their cost, which becomes a major factor for large castings. It is not possible to alloy just that part of the casting, such as the shears of a lathe bed, without alloying the whole of the casting and the cost is proportionately high. Therefore, in large castings, it is usually sufficient to have a very high grade unalloyed iron, densened where necessary, and reserve the use of alloys for the smaller components, where the benefits can be better set off against the costs. I know that some manufacturers make a great point of the use of nickel cast iron in their machine tool beds and in cases of machines for very high speeds and frequencies of operations the cost may well be justified. It is claimed that the extra costs can be offset by the reduced sections and sizes made possible by the use of stronger materials, but the necessity for rigidity and absence of vibration prevent full use being made of this, and sheer weight is often an important factor.

In the field of special and highly stressed parts alloy cast irons offer enormous opportunities. First in strength—irons are available with strengths approaching that of mild steel, which if heat treated become as strong as mild steel, whilst having the characteristics of rigidity, ease of casting, self lubrication, etc., associated with cast iron. It is important, however, to remember that owing to the presence of graphite flakes, these irons have practically no ductility.

For wear resistance, alloy cast irons are even more useful, particularly for cams. An ordinary alloy iron (nickel 1·5 chromium 0·5%) is very good, but the use of slightly higher nickel (2 to 3%) combined with hardening and tempering produces an excellent material. Such irons are machinable with a Brinell hardness of 250 to 300 as cast, even with ordinary milling cutters, and can be oil quenched from 850°C. with little variation of size to give a final hardness of 350 to 450°C, after tempering. In this condition the castings have to be ground, but the "shift" on hardening is frequently so small that

grinding after hardening is unnecessary. The use of nickel improves the uniformity of hardness throughout the casting. Other uses of alloy cast irons include gears, clutch plates, gibs, tool slides, etc.

Hydraulically-operated Machines.

The developments in the use of hydraulic power for the operation of machine tools has created a demand for castings which are pressure tight at very high pressures in spite of very intricate shapes and rapidly changing sections. The use of alloy irons with their uniform sections, small graphite, and high strength is very frequently essential. Fig. 1* shows the valve gear, and Fig. 2* shows a group of cylinders for hydraulically-operated sawing machines, tested to 1,400 lb. sq. in. without any leakage.

Other methods of improving the "ways" of machine tool beds are constantly being tried out. Hardened wearing plates attached to the beds have been tried but gave great difficulty in obtaining the necessary rigid attachment. The latest development which is interesting machine tool manufacturers is the local hardening of the "ways" by flame-hardening. This process was developed in this country by Mr. Shorter and "shorterised" products are well known, but the adaption of this process to cast iron and particularly large castings such as lathe beds is quite recent. A good machine tool iron is suitable provided that the combined carbon (that is the carbon content of the steel groundwork) is at least ·6%, although certain manufacturers claim that the presence of 1 to 1½% nickel is desirable. This is because nickel lowers the hardening temperature, thus the treatment is less drastic.

My own experiments, given in Table 2, carried out in conjunction with the Shorter Process Company, show that a first class machine tool iron of the 18-ton tensile grade gives results almost equal to the nickel cast iron. These bars were ground to 2 in. exact thickness and cleaned up after hardening to not less than 1/1000 in. under 2 in. The method of hardening is described in an article by P. A. Abe.

The Machining of Cast Iron.

I am very hesitant about dealing with this aspect before a company of engineers and feel that I am putting my head into the lion's mouth. I do not pretend to have much knowledge of feeds and speeds, cutting angles, etc. One of the difficulties is in measuring machinability, which is nearly as difficult as measuring wear resistance. I have carried out certain experiments which I will deal with later, but unfortunately these were not finished owing to the war. Certain results appeared unusual and required repeat tests.

* See pages 134 and 135 of the Journal of "The Institution of Production Engineers," April, 1940.

TABLE II.—2 in. sq. Bars Treated by Shorter Process.

Material	Original Hardness Brinell 3000/10	Final Brinell 3000/10	Hardness Vickers Diamond	Rockwell C.
Normal M/C tool iron	190	269	437	42
Special M/C tool iron	192	363	491	44
1·5 Ni ·5 Cr alloy iron	250	358	476	49
2·9 Ni ·9 Cr alloy iron	280	388	506	45

Before the days of high-speed tool steel the universal demand was for cast iron that would machine with absolute freedom, and the other properties of cast iron, when used for purposes involving any considerable machining, were entirely secondary, except in hydraulic work. The improvements that have been made in cast iron would not have been possible without the improvements that have been made in cutting tools. So that we find that as cast iron improved in strength and hardness, cutting tools became available that would deal with them. With the introduction of tungsten carbide tools no iron can really be called unmachinable. A white martensitic cast iron with a Brinell hardness of over 500 can be machined with the appropriate tool at 40 ft. per minute. Mr H. H. Beeny, of Alfred Herbert Ltd., has carried out a good deal of work on this subject.

My own observations largely confirm his conclusions, but I do not agree that tensile strength is the main guide to machinability, particularly when cutting the modern inoculated irons. With these it is possible to use just the same cutting speeds as are used for good quality irons although the tensile strength is 50% greater. We regularly use for cutting Ni-tensyl speeds of 150 ft. per min. with a cut $\frac{1}{4}$ in. wide and a feed of 1/48 in. whilst finishing speeds can be taken up to 290 ft. per min. with a 1/96 feed.

When using these high-cutting speeds the use of a machine tool that is rigid enough to stand up to the job is essential, and the figures given presume that such tools are available. Undoubtedly the best cast iron for cutting is an annealed iron and where the strength of the casting is not important this is the best material from a production point of view.

One of the most difficult problems in machining cast iron is milling, as tipped tools are not in frequent use. The speed of cut should be very closely watched.

I must include some reference to certain types of cast iron which have to be tooled, but which I have not mentioned so far, as they are not used in machine tool production. One of these is the austenitic type which demand very much slower cutting speeds and have the disadvantage of work-hardening as machining progresses. Cutting speeds for these should not exceed 80 ft. per minute and heavy cuts

are preferred to light cuts. The castings should be annealed if they are under ½ in. thick and this annealing should be followed by quick cooling, preferably quenching in oil, to obtain a fully austenitic, and therefore machinable, structure. Then there is Silal—a special heat-resisting cast iron which is very easy to machine owing to the complete absence of pearlite, except that it has a tendency to chill on thin corners. A normal anneal quickly restores full machinability. Ni-Hard, an iron with martensitic structure, in which the background is the same as that of a fully hardened steel, is best ground, but as indicated above it can be machined with tungsten carbide tools at very slow speeds. This has a limited use in machine tools, sometimes being used for centreless grinder rests.

A series of tests covering a wide range of cast irons has been carried out using the tungsten carbide tipped drill testing machine as used by Mr. Beeny. As before stated the results are not absolutely final. The figure for relative machinability is the depth of penetration of the drill per 100 revs, using a slow spiral drill ½ in. dia. under a load of 51 lb. These results are plotted against tensile strength and against Brinell Hardness, and show that neither tensile nor Brinell is a true guide to Machinability. The results for Silal are comparative with the machinability of annealed cast iron except that the Brinell would be about 160. The austenitic group cannot, of course, be considered with the others. This bears out a fact which is not sufficiently appreciated—that Brinell hardness only gives comparison of properties of similar materials.

Hard Spots.

Finally, occasional difficulties are experienced by engineers owing to hardness and unmachinability. I would explain that in his endeavour to obtain the optimum properties from cast iron the ironfounder has to make his iron as hard as possible for the section concerned. If the iron is slightly harder than expected owing to some irregularity in the working of his melting plant, or to a quicker cooling rate than expected, owing to an isolated thin part or some extraneous cause, then free carbides appear and give machining troubles.

DISCUSSION.

MR. SWIFT: How thin a section of Cast Iron could we make in the better grades, that is to say, up to 25 tons in rather big dimensions —say a ring of 3 or 4 ft. with rather big spouts coming off—6 in. spouts, about 11 of them. I would like to have your views on how thin we could run the section.

Another point regarding B.S. Spec. 786. I see that by the variation of the mixing, you can get from 9 lbs to about 23, presumably from the very wide limits, although a standard specification. I was wondering whether you do find a specification to closer limits than that

allowed in your specification, or do you just arrange either to make a lower grade or higher grade with the same specification.

MR. RUSSELL: How thin can you cast these higher grades of Iron ? $\frac{1}{4}$ is usually stated as being the minimum thickness. This will depend on the type of work to which the Foundry is used. There is no practical reason why the casting you describe could not be made $\frac{3}{16}$ limit, but you would need special Foundry technique to do it.

With regard to British Standard Specification, the specification for ordinary Castings, No. 321, has two grades ranging from 9 to $12\frac{1}{2}$ tons/sq. in., and the specification for High Duty Iron Castings, No. 786, has 4 grades, ranging from $12\frac{1}{2}$ to 26 tons/sq. in. The grade required should be specified by the purchaser.

MR. STEVENS: I would like to ask to what temperature are the machine beds heated for the flame hardening process ?

MR. RUSSELL: The illustration shows the bed immersed in a tank of water, so that only the slides are exposed. Thus the main part of the casting would not be heated above 100°C. The hardening would probably be carried out about 50°C. above the critical point, 730°C., and the surface is quenched immediately after heating.

MR. BLOOR: Can you tell us whether on the tests after flame hardening, the carriage was hardened as well.

There was no direct relationship between the Izod figure and the tensile, though it appeared to me to be fairly uniformly increasing from the slide. Is there a metallurgical reason for this being so, in spite of the normal tendency to decrease with increase in the tensile strength.

With regard to the Spindle. Can you give us some idea as to what the spindle is used for.

Can you give us some idea as to the cost of what you call standard 18 ton tensile compared with ordinary common grey iron.

MR. RUSSELL: The data I have quoted from does not state whether the carriage was hardened or not. I do not think it was.

The Izod does follow the tensile, in general, and in this it is contrary to steel.

In the case of Cast Iron, it is very largely a question of graphite which makes the cast iron brittle and the improvements in strength are due to (a) most of the strength is in the background, which apparently would not give an improved Izod strength, and (b) the improvement in the amount and arrangement of the graphite flakes. As you reduce the graphite flakes and arrange them in the random pattern, so you improve both the tensile strength and the Izod. When you take the iron and harden it, and therefore improve the matrix in tensile strength, you reduce the impact strength.

The Cast Iron spindle was definitely a lathe spindle, in general production of which we have made at least 30 or 40 of 4 or 5 different

sizes. This spindle was used to replace a forging. The shortage of supply of forgings during the war has caused many types of forgings to be replaced successfully by high duty iron castings.

On the subject of cost, this is very difficult to answer as costs vary so much from foundry to foundry. As a very rough estimate, I would say that, as compared with a 15 ton tensile Iron, it costs 1/6 per cwt. to increase strength to 18 tons, 10/- per cwt. to 22 tons, and 14/- per cwt. to 25 tons/sq. in.

MR. MARSHALL: As a member of the foundry industry who appreciate Mr Russell's knowledge and work, particularly in connection with cast irons, I should like to thank him for a very excellent lecture. We in Derby, produce what is claimed to be the most readily machined ferrous material, i.e. malleable cast iron, and are, therefore, very interested in the question of machinability.

Can Mr. Russell enlarge on the effects of some elements ? Silicon is usually stated to have an adverse effect on machining, but Schwartz has proved that both increasing in carbon and silicon improves the drilling of malleable cast iron. With regard to carbon, although the amount does not vary much in malleable cast iron, it is felt that graphite size has some influence on machinability. When speaking of inoculated irons, Mr. Russell showed that increased strength did not mean decreased machinability. Perhaps it should have been emphasised that this was due to improved graphite distribution.

Mr. Russell did stress the hardness and brittleness of the phosphide constituent. What is the hardness of this eutectic and would there be a limit to the phosphorus content for machinability where its effect on the other properties would not be important ?

Discussing relative machinability, a number of comparative figures were quoted which had been obtained by a drilling test, had the lecturer a knowledge of other tests for machinability ? Drilling appeared to give different results to other types of machining, both torque and thrust values have to be considered, and these varied without relation, with different materials. Dr. Schlesinger has stated that a variation of the standard drill would give improved results with cast iron and it would be interesting to know if such has been adopted by any machinist. Another point of interest was the prominence now being given to negative rake cutting, figures for cast iron had been quoted and probably Mr. Russell would have some further information.

Finally, Mr. Russell referred to the misnomer applied to some cast irons produced, namely "semi-steel" pointing out that even with the improved grades of cast iron, ductility could not be obtained. In this direction, the engineer should not forget that malleable cast irons can bridge the gaps between cast irons and steel as proved by its many uses, particularly in war time. Increasing use was also found

for pearlitic malleables, such material being very resistant to abrasion and heat-treatable.

MR. RUSSELL: It is obvious of course that I have been very disrespectful in ruling out malleable cast iron. We regard it as something by itself and when we refer to cast iron, we are apt to forget there is such a thing as malleable iron.

I agree that this question of graphite distribution plays a very important part in machinability. It is important not to lose sight of the original composition, but it does have a great effect if in random distribution, and what is ideal for strength, seems to be also the distribution that is ideal for machinability. As regards graphite distribution in malleable cast iron, I must confess complete ignorance.

With regard to the question of reducing machinability, I cannot help on the very low silicon irons that are used for malleable.

I do not know of any other machinability tests having been developed. The actual machine tool makers probably have their own tests, but there has been nothing to my knowledge made public, other than Mr. Beeney's work on the drill test.

It seems rather peculiar that the high phosphorus irons are not more difficult to machine than the low phosphorus. The hardness is intermittent, and when you get intermittent hardness, it does not have the effect on machinability in the same way as with continuous hardness.

MR. JENNINGS: Mr Russell has stressed the use of heat-treatment in connection with Cast Iron. In view of this, I should be pleased to know whether he thinks the future use of Cast Iron will call, generally speaking, for heat-treatment.

Perhaps he would enlarge on the snags to be expected during the heat-treatment of cast iron. When any metal is quenched from a high temperature, there is a tendency to distort it. In the case of Alloy and plain Carbon Steels, such distortion can be rectified after tempering by the use of a suitable press. This however, surely would not be the case with cast iron.

What are the scaling characteristics of castings? Normally with steel forgings the parts are rough machined prior to heat-treatment, a sufficient grinding allowance being left to account for small distortions and corrosion due to high temperature treatment.

With cast iron, would such grinding allowance be larger or smaller than with steel, and what is the possibility of being able to heat-treat cast iron in the finished condition. Would the use of heat-treatment salt help?

Is furnace atmosphere important in connection with the decarburisation of the surface layers of the metal, and if so what will be the effect on the physical properties by a reduction in carbon content in this manner.

An interesting point recently arose, when I was approached by a Machine Tool manufacturer as to the possibility of our being able to low temperature anneal the Bedplates of Lathes after rough machining.

It was explained that these Bedplates have a tendency to distort over several years, due to the internal stress set up during the casting operation. Perhaps Mr. Russell can give us some information on this aspect of machine tool construction.

MR. RUSSELL: With regard to the heat-treatment of cast iron, nearly all the heat-treatment that I have seen has been done at 850°C, and the scaling is not so severe as with steel.

The use of Alloys is recommended because you can oil quench instead of water quench, and water quenching with Cast Iron is too severe and the shock is too great, as the casting will probably fracture. The main use of the Alloy is not so much to lower the critical point as to enable you to use a slow cooling rate of quench in oil, and on the example it was quenched at 850°C. and then tempered.

It is generally accepted that cast iron distorts less on heat-treatment than steel, but it is not safe to cut down the allowance for final grinding without practical experience of the exact part being heat-treated. There is also, in some cast irons, a tendency to growth on first heating, which may be got over by a preliminiary heating and cooling before machining. The knowledge on this subject is still very meagre and considerable investigation work still requires to be done.

With regard to low temperature heat-treatment for prevention of distortion after machining. That again is raising as much interest as flame hardening. The usual temperature specified is about 500°C. I have some work going through at the moment to try and determine to what extent stresses are relieved and at what temperature. It is very frequently stated that unless you go up to 600°C., then you are creating a metallurgical change in the iron and losing some of the valuable properties. It is a compromise between annealing and taking some of the stresses out. I believe if you stress relieve at 200°C. for two weeks it would probably be the same as 500°C. for 2 hours. Time as well as temperature comes into it. Creep stress has some influence on this, and the effect is, probably, that highly stressed castings quickly respond to treatment until the stress is reduced below a certain limit, after which a higher temperature is necessary to take out any further stress.

MR. FORD: Very often the accuracy is transferred from the machine tool to the jigs or fixtures, which are used in conjunction with it.

Have any steps been taken to modify the chemical composition of the iron to make it more stable. In addition to the normal low

temperature heat-treatment, to stabilize castings, have any experiments been made with small castings by deep freezing them after low temperature heat-treatment to stabilize them more.

In the case of some of the Alloy Steels, it is found that if you give them a low temperature heat-treatment to stabilize them, and give them a deep freezing treatment afterwards for a period of about two hours and then bring them to normal temperature, it practically eliminated distortion in the case of Alloy Steel. Does the same thing happen in the case of comparatively small castings.

MR. RUSSELL: Your principal question is, can composition be adjusted to decrease the tendency to distortion? It may be a little, and I think that the older soft type of iron did not distort to the same extent as the modern stronger iron. It is a question of contraction, and these high duty cast irons do contract more than the soft open grain irons. The pattern makers contraction for soft open iron is 1 in 120, but with high duty irons, it is 1 in 96, which shows that the casting strain must be more severe.

The greatest thing anybody can do to reduce distortion in casting is to get uniform sections and try to keep the heavier parts to the outside of the casting.

I have no knowledge of deep freezing and do not know whether any work has been done on it in cast iron. I appreciate the importance of accuracy in jigs as being greater than lathes, but there is a considerable tendency to ask for jig castings to be stress relief annealed. I am not thoroughly convinced yet that it does everything that is expected of it.

Temperature is not effective alone, but it must be followed by reasonably slow cooling.

MR. THOMAS: Can Mr. Russell inform us whether the sharp change from the heating of the cast iron bed to the chilling or spraying by the water of the coolant, causes a fracture?

Secondly, was the Gear casting mentioned by Mr. Russell statically or centrifugally cast?

MR. RUSSELL: There must be a risk of cracking, but the process and composition is so controlled that this is avoided.

With regard to the gear casting, this was a static casting, not centrifugal, and there is no particular virtue in centrifugal casting.

There is of course, always a risk of slag and dirt inclusion which in a well made casting should not be there. It does reduce the risk of scrap in a centrifugal casting, but from the point of view of strength, providing the casting is a good sound casting, you can get just the same metallurgical effect as with a centrifugal casting.

MR. SHORT: Has Mr. Russell had any experience in heat-resisting cast irons? Castings for use in dies for die casting are usually worked at a temperature of 300 to 400°C., or in chilled

castings in the Sand Foundry where iron bases may be used to replace a drag mould, and may be worked at a temperature of 90°C.

I know that correct design of castings should prevent distortion and cracking, but they are often known to crack under working conditions. We use a 1% Nickel Iron for our castings and I should like to know what experience Mr. Russell has in heat-resisting iron.

MR. RUSSELL: We have developed heat-resisting cast irons such as the Austenitic, but they are not suitable for die castings in most cases, owing to their high expansion. The surface gets heated much more than the background, with the result that you tend to get surface crazing owing to the local expansion.

Cast iron is a very good material for this purpose because of the graphite which acts as an absorbent for local expansion.

It is important for heat-resisting of the type mentioned to have a fairly large proportion of graphite present. Do not get too good an iron. I think for castings of that type, Nickel which has the effect of giving small graphite, is not suitable. One of the biggest things of this type is a steel ingot metal, but in iron development they have not found anything to beat the above.

For these particular castings, I would recommend an iron with a Hematite base, with Silicon as high as you can go for the particular thickness of casting without giving such an open grained iron that it cannot take the necessary fine finish.

INSTITUTION NOTES

July, 1945

July Meetings.

7th Shrewsbury Sub-Section. A lecture will be given by R. C. Fenton, Esq., on "Negative Rake Cutting," at the Technical College, Shrewsbury, at 5 p.m.

11th Wolverhampton Graduate Section. Special meeting for Graduates and Students only. (No visitors.) "Brains Trust." Dudley and Staffordshire Technical College, at 7.00 p.m.

13th Manchester Graduate Section. A lecture will be given by D. H. Bramley, Esq., A.M.I.P.E., A.M.I.A.E. on "Planning of Production" at the College of Technology at 7.15 p.m.

17th Wolverhampton Section. A lecture will be given by W. Swift, Esq., on "Negative Rake Milling," at the Wolverhampton and Staffordshire Technical College, Wolverhampton, at 6-30 p.m.

July Committee Meetings.

24th Education Committee, at Birmingham, at 10-30 a.m.

24th Membership Committee, at Birmingham, at 12-30 p.m.

30th Research Finance Committee, at Loughborough, at 11-45 a.m.

The Technical and Publications Committee meet at Institution Headquarters every Wednesday at 5-30 p.m.

SHREWSBURY SUB-SECTION. The second meeting of this Section was held at the Technical College, Shrewsbury, on Saturday, 28th April, 1945, when Mr. R. L. Pritty lectured on "Presses, Press Tools and Allied Methods." The lecture was attended by 70 members and visitors, and was followed by a discussion in which several members of the audience participated.

At the May meeting, which was held at the Technical College, on Saturday, 26th May, 1945, Dr. D. F. Galloway, Director of Research, I.P.E., lectured on "Production Engineering Research." The attendance at this lecture was 43 members and visitors, and was followed by a discussion.

An interesting lecture entitled "Surface Formation and Location" was given by Dr. W. A. J. Chapman at the Technical College on Saturday, June 9th, and was followed by a lively discussion. The lecture was attended by 53 members and visitors.

After each meeting a letter of thanks was sent to the Lecturer and also to Mr. A. Moore, Principal of the Shrewsbury Technical College, without whose enthusiastic support the work of the Shrewsbury Sub-Section would not have been possible.

Personal.

Mr. W. E. Arnold, A.M.I.P.E., A.M.I.E.E., M.I.I.A., has been appointed General Manager of Watliff Co., Ltd., of Wimbledon and Epsom.

IMPORTANT !

In order to get the Journal out to time copy must reach the Head Office of the Institution by not later than 40 days prior to the date of issue, which will be the first of each month.

NEWLY-ELECTED MEMBERS.

As Members: G. W. S. Burdett, R. H. Buckland, H. S. Bruckshaw, N. C. H. Bodman, R. S. Brown, J. Dews, H. M. H. Fox, A. L. Kitchen, H. Nock, E. O. Schreiber, G. N. Seton, D. Willson, E. Webb, A. P. Welch, E. Williams.

As Associate Members: N. E. Allender, E. Barrs, I. F. Bellringer, J. Brook, J. Barrett, W. Bellamy, J. H. Bissell, H. Barrowclough, H. J. Bagnelle, R. Brothwell, M. E. Bell, C. C. Cornford, J. Carle, J. Carlisle, W. K. Coombe, R. S. Clark, C. E. Curzons, B. Davison, H. E. Drew, J. Dobremysl, W. R. Davies, F. Davenport, A. H. Frost, S. H. Foster, J. P. Ford, E. Fletcher, W. Frakes, J. W. Ginever, E. K. Gould, F. Gostick, R. H. Garner, A. Grainger, W. E. Hindle, E. Hampshire, A. Hazell, J. R. Hoggan, L. Harris, T. E. Hurst, J. Holmes, H. Hulme, A. Hollens, A. C. A. Johnson, P. Kerr, E. Kermeth, D. R. Kinnell, H. Kirk, M. J. Kelly, W. A. Lynch, E. S. Moores, J. McLaren, S. Myatt, A. W. Mackrell, L. W. Nickols, L. J. Parrish, J. S. Paget, T. B. Prew, W. Smith, A. D. Sennett, F. I. Standidge, J. E. Snow, G. H. Staniforth, W. Spreadborough, C. G. Suters, C. M. Toon, L. G. Wise, B. Wilcockson, O. H. Willey.

As Associates: D. N. Savile, N. R. Smith.

As Intermediate Associate Members: P. A. Allaway, E. Abnett, I. Ballard, R. H. Burt, R. C. Ball, H. C. Brock, J. G. Bowie, W. Bennett, H. Bennett, W. L. Brenchley, R. D. Barlow, W. Bone, T. B. Brook, L. H. Carpenter, G. R. Cade, S. Critchley, A. J. Carder, R. A. Criddle, F. J. Cartwright, C. Cantrell, J. H. Coleman, T. J. Clarke, L. R. Douglass, K. J. B. Dunn, A. E. R. Diment, G. V. Dawbarn, R. V. Field, L. E. Foote, R. Fishwick, R. D. Gaskin, D. Graham, V. H. Grey, W. S. Grummitt, J. Geddes, G. A. K. Geddes, G. W. Hartley, E. H. Hughes, W. J. T. Hockey, J. W. Hardman, F. Hill, N. Hindson, F. Jackson, J. Jones, A. W. Jones, R. V. Jones, N. R. King, F. Kelly, J. H. Laidlaw, V. P. Lashwood, R. M. Macarthur, W. O. McLachlan, T. McCullough, L. Moore, A. E. Morris, W. J. Murfin, A. J. May, F. W. McFadden, W. S. Muffett, F. McKeown, H. W. Pellow, S. S. Pritchard, H. Pickard, J. Robinson, D. S. Redhead, R. Rees, A. Rushworth, J. H. Rixom, R. M. Roddham, G. Robertson, A. E. Ranger, E. E. Storm, F. H. Smart, G. E. Smith, W. Steel, C. G. Smallwood, L. C. Seager, C. Schofield, E. J. S. Triggs, G. E. Velge, S. C. M. Vincent-Ambler, L. F. Withers, H. F. Webb, E. R. Weston, T. E. Webster, E. A. Webster, L. S. Wheatley, E. T. Webb.

As Graduates: S. Armstrong, G. H. Armes, A. Ali, J. Abbott, T. S. Bugg, D. B. Bridge, F. Clymer, A. Davenport, S. Evans, F. Howarth, W. M. Harrison, J. Y. Ireland, L. P. King, G. Lyon, C. Moore, N. T. Meek, R. G. Masters, A. L. Orton, C. B. H. Parry, W. J. C. Parry, D. Price-Stephens, D. G. I. Rosser, C. Squire, R. Smith, W. T. Scarr, J. A. Taylor, D. E. Turner, L. Walker, D. Williams.

As Students: W. H. Aston, R. Arrowsmith, R. W. Bungay, L. Bowen, V. A. Benning, A. Casserley, M. H. Choules, P. R. Corbett, N. Dodgson, D. W. Dewar, E. Dugdale, A. H. Edge, E. Evans, K. Egan, D. F. J. Flook, S. H. Fry, W. M. Faulds, D. J. I. Gray, E. Garside, R. G. F. Griffin, A. V. J. Godsell, C. A. O. Hewer, W. G. Hearle, S. R. Howe, E. A. Hewitt, D. W. Hughes, R. Hedley, J. R. Hellens, B. G. Harris, D. C. Howard, L. H. Jackson, E. Jackson, W. J. Kease, J. A. Kidd, J. P. Lendrum, G. Long, A. D. Macaskill, C. Meadowcroft, E. Mottram, T. M. Moraghan, W. J. W. Metcalfe, L. W. Myers, A. H. Newton, S. Ormondroyd, R. G. Porter, C. A. Perry, W. R. Pryce, A. Platt, J. K. Priest, J. Pearson, A. E. V. Page, E. A. Rice, H. Repper, J. Rook, G. C. Sharp, G. C. Siddle, G. R. Shearer, D. G. Stretch, K. Stokoe, D. H. Topham, G. R. Tryer, N. R. Wright, C. O. Webb, R. R. Walford, B. Whittaker, F. C. Williams.

As Affiliated Firms:	Affiliated Representatives:
Guest, Keen & Nettlefolds, Ltd.	Sir Anthony Bowlby, Bart. Frank B. White.
Leo S. Steinle, Ltd.	Leo C. Steinle. R. B. Webb.
S. Osborn & Co., Ltd.	Cecil S. Hurst. Frank A. Martin.
Stothert & Pitt, Ltd.	Arthur O. Day.
Sure-Tools, Ltd.	R. H. Stenning. A. E. Stenning.

TRANSFERS.

From Associate Member to Member: A. Beeching, F. Cotton, J. H. Gleeson, R. S. Hind, J. G. Holmes, P. G. H. Jeffrey.

From Associate to Associate Member: R. Appleby.

From Intermediate Associate Member to Associate Member: H. C. Blackford, D. F. Bate, S. Davey, C. Godden, H. Ison, H. Rothwell, F. D. H. Ronald, F. E. Wall, A. G. Williams.

From Graduate to Associate Member: E. Byron, T. T. Franks, J. L. Hepworth, G. D. Ingham, B. Jenkins, A. H. Mills, R. A. Rogers, F. C. Shelley, J. H. Tomes, R. Taylor.

From Graduate to Intermediate Associate Member: G. H. Allwood, H. L. Adams, K. H. Aston, K. S. Ayapa, C. A. I. Blackwell, W. H. Boswell, C. J. Foster, R. J. Fraser, A. G. Lee, A. S. Nicholls, W. C. Rickards, G. Trubshaw, E. T. C. Wheeler, L. P. Wilson.

From Student to Graduate: A. S. Ault, H. Bolton, J. E. Clausen, P. S. Dunford, D. Foulger, R. C. Kinsley, M. F. Mansell, J. I. Williams, D. H. Williamson.

BOOK REVIEW.

Rolling Bearings, by R. K. Allan, M.I.P.E., A.M.I.Mech.E. London: Sir Isaac Pitman & Sons, Ltd. Price 30s. net.

Many papers have been published in the transactions of engineering institutions and articles in the technical press on the various types of bearings used in general engineering practice, but a long felt want has been filled by the appearance of this book by a recognised authority.

The book deals comprehensively with an historical outline in Section I. and the basic principles of bearing design are set out very clearly in Sections II. and III. It is suggested by the author that only a "nodding acquaintance" has been given on materials and manufacture, but this subject has been well covered in Section IV. and will be extremely useful to designers and engineers. Sections V., VI., and VII., deal with the development of the Hertzian theory as applied to bearings, and the works of Professor Stribeck, Professor John Goodman and Dr. Palmgren. Formulæ has been analysed and arranged in a very convenient manner, together with examples of its application. The design section is rounded off by a chapter devoted to a summary of the various types of bearings in use and will undoubtedly be extremely useful as reference.

The practical side as distinct from the theoretical design is covered by Sections IX. to XV. and Section X. has a wealth of information which can be put to very good use by the Machine Designer, namely, Bearing Selection and Application, wherein shaft and housing design is very fully explained and illustrated.

Lubrication, a most important point so often overlooked, is very clearly explained in Section XI., and various types of both grease and oil lubrication schemes are described and illustrated. Limits and Fits, a rather controversial subject where rolling bearings are concerned, are described in Section XII. Finally, Sections XIII. and XIV. deal with the Fitting, Maintenance Repairs and Service of bearings, together with a very complete Bibliography in Section XVI., covering a list of books and articles which have been written on this subject and a list of bearing manufacturers.

A valuable work has been provided by the author which should be in the hands of all designers and engineers who are interested in this most important and interesting subject.

J. W. H. S.

Research Department: Production Engineering Abstracts

(Prepared by the Research Department.)

NOTE.—*The Addresses of the publications referred to in these Abstracts may be obtained on application to the Research Department, Loughborough College, Loughborough. Readers applying for information regarding any abstract should give full particulars printed at the head of that abstract including the name and date of the periodical.*

HEAT TREATMENT.

Induction Heating. (*Sheet Metal Industries, May*, 1945, *Vol.* 21, No. 217, p. 837, 8 *figs.*)

Part VII. The miscellaneous applications described comprise: bright flowing of electrolytic tin plate in continuous strip plants; paint and lacquer drying; forging bomb and shell cases; and annealing and normalising.

High Frequency Heating in Production Engineering, by A. L. Simmons. (*The Australasian Engineer, 7th February*, 1945, *Vol.* 44, *No.* 344, *p.* 35, 12 *figs.*)

After explaining the elementary electrical fundamentals, induction heating applications are described. These include small arms components. Dielectric heating and its applications are then described in a similar manner. Finally, power requirements and equipment are outlined.

ACCOUNTING ADMINISTRATION.

A Cost-finding Chart for Industry, by S. C. Roberts. (*Mechanical World, 4th, 11th May*, 1945, *Vol.* 117, *Nos.* 3044 *and* 3045, *pp.* 485 *and* 520, 2 *figs.*)

A chart which has the unusual feature of being applicable to any industry is described. It covers the differences of labour and material costing, and discusses the scientific distribution of overhead expenses. Its principles and application are described in considerable detail.

EMPLOYEES.

Foundations for Constructive Labor Relations, by R. Carter Nyman. (*Personnel, (U.S.A.), March*, 1945, *Vol.* 21, *No.* 5, *p.* 278.)

Management must revise its concept of its function and responsibility in labour relations. It must bring to bear upon the problems of industrial relations the same professional objectivity that characterises its approach in the technological field. Describing three psychologically sound methods of solving labour problems, the author shows how the engineering approach can be applied to human relations. The methods outlined, he believes, may go far to resolve the old destructive conflict for domination between capital and labour. U.S. conditions are primarily considered.

Getting Along on the Job : A Guide to Good Work Relations, by H. A. Bolz. (*Personnel, (U.S.A.), March,* 1945, *Vol.* 21, *No.* 5, *p.* 272.)

Since an organisation is no stronger than the weakest member of its staff, every employee has a distinct responsibility to prevent personal friction from disrupting harmonious relations. The author outlines a number of elementary (but frequently overlooked) precepts whose consistent observance will serve to lubricate friction spots in dealing with one's superiors or subordinates. Also outlined are a number of helpful rules for handling one's self and one's work.

FOUNDRY.

The (British) War-Time Aluminium Foundry, by G. Mortimer. (*Metallurgia, bruary,* 1945, *Vol.* 31, *No.* 184, *pp.* 187-196.)

Brief survey of war-time progress. Considers sand, gravity and pressure die casting.

(*Communicated by the British Non-Ferrous Metals Research Association.*)

GEARING.

Split Marking on Gear Teeth, by W. A. Tuplin. (*The Machinist, 5th May,* 1945, *Vol.* 89, *No.* 4, *p.* 115.)

The simplest check on general accuracy of form of gear teeth is to inspect the contact marking produced by running the mating gears together whilst mounted in their correct relative positions. It is sometimes found that the marking test on spur or helical gears reveals a band of unmarked metal lying about half-way up the tooth and extending across its whole width. This condition is called "double marking" or "split marking" and often raises doubts as to the accuracy of the tooth profiles of the gears that show it. Profile accuracy can be tested in another, and almost equally simple way and that is to run the gears at full speed. If they work quietly, the errors in tooth pitch and profile must be very small. It has not been found that gears with a split marking have any noticeable tendency to noisy running and this means that inaccuracies must be very small indeed. A suggested explanation is put forward. It is also noted that simple checking methods may be very sensitive, and that for gears no test, however elaborate, is so decisive as the simple running test at full speed.

MACHINE ELEMENTS.

Bearing Operating Temperatures. (*Power Transmission, 15th May,* 1945, *Vol.* 14, *No.* 160, *p.* 396.)

Usual workshop methods for ascertaining and checking the temperature of machine-spindle or shaft bearings are generally unreliable and of a makeshift nature. The writer suggests that makers incorporate accurate thermometer-testing equipment, or an electrical registering device which would show a red light when the danger point of bearing temperature is reached.

Small Flexible Shaft Couplings, by R. Waring-Brown. (*Power Transmission, 15th May,* 1945, *Vol.* 14, *No.* 160, *p.* 377, 6 *figs.*)

Particular reference is made to shaft couplings transmitting small powers, where universal flexibility depends upon rubber.

The Design of Balancing Machines, by F. Campbell Rose. (*Aircraft Engineering, May,* 1945, *Vol. XVII, No.* 195, *p.* 149, 11 *figs.*)

There are two conditions under which a rotating part may be out of balance, force unbalance and couple unbalance. Static balancing machines offer the simplest type of balancing equipment. They may be used for correcting force unbalance, but cannot detect the presence of couple unbalance, and can therefore only be used for narrow rotors, flywheels, etc. Dynamic balancing machines respond to both force and couple unbalance, and must be used whenever a fully balanced rotor is required. The force due to an unbalanced mass in a rotating part is proportioned to the mass, the radius at which it is situated, and the square of the rotational speed. Correction is best applied at the maximum available radius, so that the amount of correction is least in terms of the mass added or removed. In cases where the location of any possible correction is limited to certain predetermined positions (e.g., crank shaft webs), four such positions will be required. These must occupy, in general, at least two separate transverse planes, and two different angular positions. On the other hand, where the whole circumference of the rotor is available for applying corrections as is usually the case (e.g., in electrical machines), complete dynamic balance may be achieved by two corrections only, one in each of two arbitrarily selected planes of correction. These two corrections may be made independent of each other by constraining the rotor with pivots in one plane of correction, while correcting in the other plane. For this purpose actual pivots may be used, or an equivalent effect may be produced by electrical compensation. In the examples given of current practice, one purely mechanical method is described. Reference is also made to various systems using electrical pick-ups to detect the movement due to unbalance in a flexibly mounted rotor. It is also pointed out that rotors, assumed to be rigid, may in practice suffer deformation under centrifugal stress. This deformation may be elastic or plastic in character. In either case, this deformation must be eliminated before the balancing process can be carried out effectively.

MACHINE TOOLS.

The British Machine Tool Industry, by L. A. Ferney. (*The Engineer, 25th May,* 1945, *Vol. CLXXIX, No.* 4663, p. 406.)

Part I. Machine tools are the converters of metals into finished articles, but the industry, judged by the capital invested in it, value of its output, or numbers employed, occupies but a modest place in the economy of any country. Only five countries in the world possess what might be properly called machine tool industries, the U.S.A., Germany, Great Britain, U.S.S.R., and Switzerland. Even in these countries the proportion of the industrial effort devoted to their building, the capital invested in the industry, and the number employed is relatively very small. Thus, in 1930, the United Kingdom machine tool output was valued at approximately 0·2 per cent. of the total industrial output. England and America between them have produced the modern machine tool. The primary machine tools were all born in England. Americans began making machine tools at the break of the nineteenth century, their contribution being mainly in the field of special machines and in methods of manufacture. The principle of interchangeability was the first step towards mass production and also towards scientific management and in these America has been a leader. The German machine tool industry was born rather later (some time after the Franco-Prussian War), but grew with great rapidity. Switzerland is the acknowledged home of the watch trade, and with the call for good, mass-produced watches, there also came the call for machines precise enough to make extremely accurate watch parts cheaply by machinery. The Swiss applied themselves to this task with scientific care, and in certain lines have enjoyed a monopoly for

many years, maintained by the excellence and low prices of the products. After giving further statistical data on the British machine tool trade, the author considers critically the technical position of the trade and states that, compared with other machine tool producing countries, the United Kingdom had before the war very few large producers of tools. The development of an entirely new type of machine, such as a multi-spindle automatic, may take several years and cost £50,000 in the design stage and a further £100,000 for jigs and tools to ensure its economic production in quantity. The bulk of the British machine tool firms are private, old-established concerns, in which the management is not appointed, but inherited, and " rugged individualism " prevails. The Yorkshire trade, in particular, has had such a character ; the average works employed about 200 hands and had a working capital of £20,000 to £50,000. Such firms could not invest their total working capital in the development of one new type of machine and had not sufficient resource to manufacture old established designs efficiently. Neither were they psychologically ready to accept new ideas. There were, of course, makers of first-class machine tools in this country. These firms produced machines as good as any in the world within their own range. They employed modern methods, developed new types, and, in general, contributed to the pool of knowledge on machine tools and machinability. The bulk of the firms, however, relied on the skill of their workers and the tradition built up in their works to turn out machines which were saleable, and not a few of them were living on reputations established many years ago, and which were not always justified by their present day quality.

Shop Men Give Their Ideas on Improving Machine Tools. (*The Machinist*, 19*th May*, 1945, *Vol.* 89, *No.* 6, *p.* 213.)

This further selection of views includes : Better chip collection and removal, more attention to design to prevent leakage and splash of lubricating oil and cutting lubricants, standardization of coolant pump design, easier slinging and lifting, more rigidity and power, easier maintenance and electrical accessibility, more standardization in the designation of machine size, and full automatic lubrication.

Waagrechtbohren. Horizontal boring, by H. Martini. (*Fertigungstechnik*, 1943, *Vol.* 1/77, *pp.* 79-81.)

Two boring bars with micrometric fine adjustment ; using wedge plate and differential screw ; material ; hints on the design of the work ; adjustment of the boring spindle and the work ; adjustment with expanding arbor and gauge ; tables of calipers ; illus.

(*Communicated by Industrial Diamond Review.*)

Electronic Torque Control Prevents Drill Breakage. (*Machinery*, 10*th May*, 1945, *Vol.* 66, *No.* 1700, *p.* 507, 3 *figs.*)

Experience has shown that the automatic withdrawal of deep hole drills when thrust has exceeded a certain amount is not always sufficiently sensitive, and means of using drill torque as the controlling factor have been developed. The principle of the torque control unit is the amplification, through vacuum tubes, of the torque-load variations of the electric motor driving the drill. Drilling continues at the feed rate until an excessive torque force is applied to the drill, due to either undue pressure or the accumulation of chips in the flutes. The torque device then functions, causing the head to be retracted to its starting position at the rapid traverse rate.

Hard Tipped Steel Pipe for Drilling Ceramics, by K. J. Trigger. (*Mining and Metallurgical Engineering Newsletter, March,* 1945.)

(Abstract from *Metals and Alloys,* February, 1945.) The drilling of holes through fire brick or similar ceramic material presents a problem in furnace maintenance. Recently, several 1⅜-in. dia. holes had to be drilled through a 5-in. thick replacement furnace lining. Four of the holes were to emerge tangent to the inside diameter of the lining and proper alignment was deemed highly desirable. Star drills were suggested, but were considered unsuitable and finally the following drilling procedure was applied: a standard taper shank (No. 4 Morse) was turned parallel for 2 in., leaving a square shoulder. One end of a 10-in. length of 1-in. extra strong steel pipe was bored under size for a press fit on the shank. At the opposite end four slots ¼ in. wide by ¼ in. deep were milled on two diameters at 90 degrees. Four recesses ⅛ in. deep, ¼ in. wide, were then milled adjacent to the previous slots. Deposits of a hard facing consisting of 10 mesh tungsten carbide particles in a mild steel jacket were arc welded into each recess only, the ¼-in. slot being left for "chip" space. Since great accuracy was not required, the welded deposits were not dressed. The assembly was mounted in a radial drill and adjusted to 125 r.p.m., giving a peripheral speed of 45 f.p.m. The holes were located through the steel furnace jacket and drilled by hand at a rate of approximately 1 in. per minute. The elapsed time per hole, 5 in. (12·5 cm.) deep, was from 6 to 7 min., including the backing out of the drill for removal of the drillings. All drilling was done dry. In evaluating the drilling method described, compare the rate with that of a previous experience wherein a 2-in. diameter hole drilled by means of a rock bit and a slurry of 80-mesh carborundum required somewhat over 2 hours for a 4½-in. depth of hole. In order to test the special drill on other ceramic materials, several grades and types of brick were drilled. The original drill was used in all tests, the holes being 1⅜ in. diameter in each brick. A drill, such as that described, may be prepared at little expense in a few minutes. Slot sizes and spacing may be varied, but the spacing should be even to avoid excessive side thrust. The method described is recommended as an accurate and inexpensive way of drilling various ceramic materials wherein the cost of more expensive drill bits is not justified.

(*Communicated by the U.S. Office of War Information, London.*)

Wheel Truing for Fine Grinding, by H. J. Wills and H. J. Ingram. (*Machinery, 24th May,* 1945, *Vol.* 66, *No.* 1702, *p.* 573.)

After stressing the different aims of truing and dressing, the authors outline the general technique to be adopted.

CHIPLESS MACHINING.

Forging Automobile Crankshafts on High-Speed Mechanical Presses. (*Mechanical and Electrical Engineering Newsletter, April,* 1945.)

(Abstract from *Machinery,* (N.Y.), March, 1945.) The forging of automobile crankshafts having integral counterweights has been accomplished successfully on a heavy-tonnage high-speed mechanical forging press.

(*Communicated by the U.S. Office of War Information, London.*)

Composite Die Sections Save Time and are Economical. (*The Machinist, 19th May,* 1945, *Vol.* 89, *No.* 6, *p.*215, 6 *figs.*)

Electrically welded composite die sections have been used extensively by the automotive industry for many years, but are scarcely known elsewhere. Their construction and application are described with the aid of an example.

MANUFACTURING METHODS.

Common Factors of Time Study in Light Industry, by S. Bloye Dipple. (*Mechanical World*, *4th*, *18th May*, 1945, *Vol.* 117, *Nos.* 3044 *and* 3046, *pp.* 492 *and* 548, 1 *fig.*)

Practical examples of the principles and methods explained in earlier articles are discussed. These include time standards for press and drilling operations and methods suitable for processes in which there is no mechanical controlling factor.

MATERIALS AND MATERIAL TESTING.

A Magnetic Comparator for Sorting of Ferrous Alloys, by A. A. Townsend. (*The Australasian Engineer*, *7th March*, 1945, *Vol.* 44, *No.* 345, *p.* 42, 3 *figs.*)

The device described compares the product of the permeability and a function of the dimensions of the specimen, with the product for a standard specimen. If the dimensions are identical, then the instrument indicates differences in permeability, which may be attributed to differences in chemical composition or structure from the standard specimen. Accurate and rapid sorting of steel bar stock is possible with the apparatus and provided a reasonable gain setting is adopted, there is little likelihood of anyone using it incorrectly. The separation of material with respect to heat treament is also definite, although the gain setting for easiest sorting is a little more critical. The detection of faults is not possible unless the fault is due to a bulk change, such as carbon segregation. Data on suitable coils of various diameters is given.

The Appreciation of High-Duty Irons for Machine Tool Construction, by E. M. Currie. (*Machine Shop Magazine*, *May*, 1945, *Vol.* 6, *No.* 5, *p.* 51, 2 *figs.*)

In the machine tool industry high-duty irons, such as Meehanite metal, have been in extensive use for tool shanks, milling cutter bodies, collets, chucks, lathe mainshafts, jigs and gauges, tool-holders, gears, etc., replacing various steels ; in bearings replacing bronzes and other non-ferrous combinations, and in lever brackets and other actuating mechanisms replacing malleable cast irons. Where the designer persists in regarding any high-duty iron merely as a super-strength cast iron, no real achievement or advancement becomes possible. Its place is filling the gap between the properties of the grey cast irons and the steels, and a unique combination of certain physical properties makes it peculiarly useful in a distinct field of its own. Ultimate tensile strength means little to the design engineer. Of much more importance are yield strength, elasticity modulus, and fatigue. Even so, to determine the service suitability of a material on the results of a relatively limited number of well-known static and dynamic tests may lead the designer astray, and it is among the " secondary " physical characteristics of a material that the proper answer to suitability may be found. These include stability, damping capacity, wear resistance, controllable machinability, and ability to be processed under heat treatments without excessive deformation occurring. None of these can be easily defined, but a resumé of the available tests is given, with particular reference to the performance of Meehanite metals relative to steel or cast-iron. It is claimed that owing to the increasing speeds, cuts, tool pressures, new cutting materials and still faster production times, designers and constructors of precision machine tools must of necessity turn from the variable grey cast irons with uncontrollable properties to those high-duty irons which can be processed and manufactured for whatever particular physical property may be specified.

Magnesium—A New Engineering Material, by W. E. Prytherch. (*Engineering Materials, April,* 1945, *Vol. III, No.* 5, *p.* 53.)

In recent years, rapid advances have been made in the technology of magnesium, and it can now be said that the problem of making the material reasonably resistant to corrosion has been solved. Most of the technical difficulties of production have been overcome.

Testing Hardened and Tempered Components. (*Industrial Diamond Review, May,* 1945, *Vol.* 5, *No.* 54, *p.* 102.)

German investigations on this subject have led to certain recommendations being made for the hardness testing of hardened and highly tempered components to lead to the simplification of and increased uniformity in production. For the testing of components of more than 400 Vickers or 40 Rockwell C, the following can be applied: (1) Vickers, (2) Rockwell-C, (3) Shore hardness test, and (4) Filing test. The features and scope of each test are discussed.

Holder Designed for Wedge-Drawing Tests. (*The Machinist, 26th May,* 1945, *Vol.* 89, *No.* 7, *p.* 225, 5 *figs.*)

The wedge-drawing test is to-day being considered as a possible basis for the commercial testing of the deep-drawing properties of sheet and strip material because it simulates the conditions of true drawing more nearly than either the tensile test or the cup test. Apparatus for the tests are described.

MEASURING METHODS, INSPECTION.

The Use of Radio-frequency Apparatus in Inspection, by James Cornelius (*Machinery, 3rd May,* 1945, *Vol.* 66, *No.* 1699, *p.* 473, 5 *figs.*)

The employment of radio-frequency apparatus to measure such minute variations as the one-thousandth part of a millionth of an inch is now possible, and an instrument has been made by which this variation can be detected. The apparatus costs but a fraction of that required for an instrument of the mechanical type which will detect to the degree of one-hundred thousandth part of an inch. It employs no mechcanical magnification whatsoever, and the accuracy is not impaired by any ordinary misuse. The apparatus comprises two units, the measuring unit, and the amplifier. The circuit which is employed is shown, and the sensitivity and calibration of the instrument are discussed.

PLASTICS.

Water-Resistant Films of Plastic Materials, by P. D. Ritchie and I. W. A. Kirkwood. (*Engineering Materials, April,* 1945, *Vol. III, No.* 5, *p.* 51.

There are three main methods of application, each with its own particular advantages:—

(*a*) Dipping in or spraying with a protective material, giving a coating which may subsequently be removed mechanically or by solvents, or left *in situ,* as required.

(*b*) Wrapping in an impermeable film of the Cellophane type, with the edges suitably sealed.

(*c*) Wrapping with a reinforced composite or laminated sheet.

These methods are considered in detail.

SMALL TOOLS.

Factors in the Application of Carbide Cutters. (*Machinery*, 3*rd May*, 1945, *Vol.* 66, *No.* 1699, *p.* 482, 3 *figs.*)

This U.S.A. War Production Report summarises information on operating precautions, multiple cutter mounting, cutter location in relation to work; cutter maintenance, speed, feed, number of teeth and power, and fly-cutting.

Correct Angles Improve Efficiency of End Mills and Side Mills, by M. Martellotti. (*The Machinist*, 19*th May*, 1945, *Vol.* 89, *No.* 6, *p.* 206, 10 *figs.*)

This article, the sixth in a continuing series, discusses various items to consider in selecting angles for milling.

Maximum Service from Cutting Tool Materials, by J. F. C. Morden. (*Engineering Materials, February*, 1945, *Vol.* 3, *pp.* 23-31.)

Discusses what savings can be obtained in the workshop by improvements in the life of tools, i.e., maximum production per hour, economy in setters' time, savings in tool costs, tool life is influenced by: correct cutting angles, correct feeds and speeds, suitable tool materials, correct heat treatment of the tool (where necessary), optimum finish of tool edge, well maintained machines, suitable lubricants, planned setting and tool replacements, suitable heat treatment or condition of the material to be machined, well trained operators.

(*Communicated by Industrial Diamond Review.*)

SURFACE AND SURFACE TREATMENT.

Surface Roughness and Sliding Friction, by J. J. Bikerman. (*Reviews of Modern Physics, January*, 1944, *Vol.* 16, *pp.* 53-68.)

Introduction; surface roughness, general remarks, method of measurement: method involving no solid contact (optical methods and total surface area), methods involving a contact between solids (tracer method, contact between flat surfaces, electrical contacts); sliding friction, Coulomb's theory of the mechanism of friction interface layers and their elimination, adhesion theory of friction, resistance to sliding and sliding friction, mono-molecular layer of lubricant, thicker lubricating films, journal bearings; 126 references.

(*Communicated by Industrial Diamond Review.*)

Reclaiming and Hardening of Engineering Components by Electrodeposition, by H. Merryweather. (*Engineering*, 18*th and* 25*th May*, 1945, *Vol.* 159, *Nos.* 4140 *and* 4141, *p.* 398 *and* 419, 9 *figs.*)

The industry is divided into two definite sections: (1) electroplaters and (2) electrodepositors who specialise in thick, homogeneous, firmly adherent deposits, or thin coatings deposited to limits within reasonable tolerances. The latter are very much in the minority and it is doubtful whether there are more than ten fully approved firms of this type in the British Isles. Great prominence is given to nickel and chromium as salvage media and the advantages of cadmium tend to be overlooked, but its use in certain specified conditions involving thin deposits is ideal. Chromium is probably the metal which is in greatest demand to-day and is used for (*a*) the salvage of components having high hardness characteristics; (*b*) the hardening of components or portions thereof; and (*c*) thin controlled deposits to withstand abrasion. Experience during the past

few years have made it advisable to reduce the maximum recommended wall thickness of hard chromium deposits to 0·015 in. The hardness of chromium and its "anti-seize" properties are the reasons for its popularity. Practical experience favours the view that occlusion of hydrogen in the deposit, during processing, is a most important contributory factor in the hardness of the deposit. Careful control of the plating conditions ensures an average hardness of 820 to 840 Brinell. It is most important to avoid any of the following conditions in the final grinding operation, any of which are likely to cause trouble: (1) incorrect viscosity of the cooling medium; (2) "dry" grinding; (3) "striking" the grinding wheel on the plated surface before turning on the cooling medium; and (4) taking off large roughing cuts. A finished thickness of 0·006 in. is satisfactory for all purposes where a hard protective surface is required. This treatment has been found satisfactory for the rockers of internal-combustion engines; steam-heated pressure platens for plastic moulding; pistons for pneumatic road breaking tools; aero-engine valve rockets, etc. The application of hard chromium deposition to tools is proceeding apace. On tools where impact is experienced, thick deposits should not be employed; 0·005 in. on a radius is suggested as a maximum. On punches, it has been found beneficial to reduce the average hardness of the chromium from 820 Brinell to 600 Brinell. Drills are being treated in rapidly increasing numbers, and to obtain correct results it is essential that the flutes of the drill should be given a reasonably high finish before treatment. A deposit of from 0·0002 in. to 0·0005 in. is usual, the object being to reduce to a minimum the friction of the metal passing up the flute. The electrodepositor, when considering the case of electrodeposition for machine tools, is in a difficult position unless he possesses a good practical engineering knowledge. This is seldom the case and it is desirable, therefore, that the utmost co-operation should take place between the engineer and the electrodepositor. The successful deposition of hard chromium on internal diameters is a severe test for the electro-depositor, but it can be done, and examples are given which are described. External diameters are easier to process than internal ones, but there are exceptions. It is explained why it is not normally commercially possible to hold thicker deposits to the same dimensional specification as thin deposits. The cost of hard-chromium deposits is a large and difficult subject when considered in conjunction with the infinite variety of components handled, and the varying sets of conditions that arise with different thicknesses of deposit, etc., but, in short, the cost of salvage work is based on the cubic space the work occupies in the vat, plus the hours of deposition, with a sliding scale to compensate for very large or very small areas of deposition. Nickel can be applied in greater thicknesses than chromium, thus covering wider applications. Nickel in its electro-deposited form can be obtained in two ranges of hardness: (1) approximately 200 Brinell, and (2) approximately 300 Brinell. The first type of deposit can be subjected to all the usual machining operations, and the same can generally be said of the harder type, except that, very often, the hardness can run up to 350 Brinell, and unless due care is exercised, difficulty will be experienced. Machining recommendations are given. Thin deposits can be provided satisfactorily with absolutely certain adhesion on ferrous metals and it is believed that the maximum thickness possible has not yet been determined, but 0·4 in. has been obtained. For component rectification the amount of metal removed is less than 0·005 in., and is probably in the region of 0·002 in. An interesting example which illustrates the firm adherence of deposited nickel is shown, in which nickel having a wall thickness of 0·10 in. was deposited to enable a thread to be re-cut. One of the undesirable features of thick nickel deposits is the nodule growth on the extremities of the deposited area, and the method of dealing with them is indicated. The overlapping of a salvaged area with nickel by the depositor is often a cause of irritation to the engineer, but it is very necessary because the wax stopping-off medium weakens the adhesion of the nickel adjacent to the wax, and therefore, to prevent the wax from coming close to the deposited area proper, this area is increased by approximately $\frac{1}{4}$ in. all

round. The deposition of nickel is also utilised by engineers for application to components to give resistance to attack by acids, alkalis and other reagents.

Rectification and Surface Hardening of Screw Threads by Electrodeposition. (*Machinery*, 3*rd May*, 1945, *Vol.* 66, *No.* 1699, *p.* 497.)

(E.T.A.C. Technical Memorandum, No. 2.) Electrodeposition applied to screw threads may be for one of the following purposes: (1) Protection from corrosion. (2) Rectification of worn or over-machined threads. (3) Provision of a non-seizing or non-scoring surface. (4) Surface hardening, especially on screw gauges. These points are considered in turn, with the exception of the first. The address for obtaining full copies of the memorandum is: The Secretary, Electrodeposition Technical Advisory Committee (Armament Research Department, Ministry of Supply), c/o S.T.A.M., Room 1043, Shell Mex House, Strand, London, W.C.2.

The Electro-polishing of Metals, by N. A. Tope. (*Engineering Materials*, *April*, 1945, *Vol. III*, *No.* 5, *p.* 63, 7 *figs.*)

In mechanical polishing the relatively brutal treatment leaves the surface of the metal in a hard and brittle condition, known as the "Beilby Layer". In electro-polishing the work is used as an electrode in an electrolytic bath. The current, taking the line of least resistance, preferentially passes from the high spots, and they are dissolved at a greater rate than the rest of the surface. As projections of greater magnitude dissolve, the current passes to more secondary projections until the whole surface is reduced to a common level. The surfaces are not optically flat, since the polished surface follows the facets of the metal crystals, and the reflection of light is similar to that obtained from a cut diamond, but on an infinitely greater scale. A typical degree of roughness on electro-polished steel is of the order 10 micro inches. The process was first used for the preparation of metallurgical microscope specimens and a summary of the outstanding methods is given. Commerical processes for aluminium fall into three main patent groups, of which the British "Brytal" process is described. Stainless steel is widely used in the U.S.A. for decorative purposes; the mechanical polishing of this material is difficult and expensive and since many grades are almost ideally suited for electro-polishing, the latter method has found increasing favour. Discussing future trends, the author states that it is improbable that electro-polishing will completely displace the mechanical process of "bright plating," but electrolytic polishing should assist bright plating by providing a superior and more consistent polish and eliminating the necessity for etching prior to plating. Due to the relatively high cost and inflexibility of the electro-polishing equipment and electrolyte, the process should be most efficiently employed with mass production processes, and should be at its best when used for the treatment of pure metals and certain simple alloys. The future uses of the process may fall into the following main categories: Decorative work; the production of reflectors; for engineering purposes and as an aid to inspection.

Electrolytic Methods of Polishing Metals, by S. Wernick. (*Sheet Metal Industries*, *May*, 1945, *Vol.* 21, *No.* 217, *p.* 844, 14 *figs.*)

Part. VII. Electro-brightening copper and silver.

Analysis of Silver Plating Solutions—A Simple Electrometric Method, by J. N. Gregory and R. R. Hughan. (*Chemical Engineering and Chemistry Newsletter*, *March*, 1945.)

(Abstract from *Industrial and Engineering Chemistry*, February, 1945.) The estimation of free cyanide and argenticyanide in a silver-plating solution can

both be carried out in the one titration, using electrometric methods to detect the Liebig end point and the point of complete precipitation of silver cyanide. The accuracy of the electrometric method is much in excess of that usually required for electro-plating solution analysis, and the sensitivity of the end point is much less than one drop (0·03 ml.) of 0·2 N silver nitrate.

(*Communicated by the U.S. Office of War Information, London.*)

Metal Finishing, by H. Silman. (*Sheet Metal Industries, May*, 1945, *Vol.* 21, *No.* 217, *p.* 859, 5 *figs.*)

Part VI. Electro-plating: modern equipment and technique.

Coated Abrasives for Production Surface Finishing, by J. Albin. (*The Iron Age*, 18*th January*, 1945.)

Increased accuracy and greater flexibility are being attained with coated abrasive belts on jobs that impose a surface finish requirement with stock removal on a low production cost basis. Various types of abrasive belting machines are described, ranging from bench units to a vertical machine for finishing the head of a torpedo.

(*Communicated by Machine Shop Magazine.*)

WELDING AND CUTTING.

System of Indicating Welding Requirements on Engineering Drawings, by H. S. G. Gardner. (*Transactions of the Institute of Welding, February*, 1945, *Vol.* 8, *No.* 1, *pp.* 38-47.)

A collection of information and data for the use of design office staff, covering the majority of welding processes and most of the metals and alloys commonly welded.

(*Communicated by The British Non-Ferrous Metals Research Association.*)

Welding Without Fusion, by R. F. Tylecote. (*Engineering Materials, April*, 1945, *Vol. III, No.* 5, *p.* 54.)

The essentials of the process as far as the butt welding of bars or rolled sections is concerned are relatively smooth, clean surfaces, abutted with a pressure of the order of 1 ton per square inch. Heat is applied locally either by means of an oxy-acetylene flame or a resistance (butt) welding machine and the bars are heated in the case of steel to about 1,150°C. The pressure upsets the metal near the weld interface as the temperature rises. The temperature is maintained for a short time after upsetting, and the joint allowed to cool. There are several examples of this process already in operation: (1) The butt welding of copper wires and bars; (2) the pressure welding of pipe lines and tubes; and (3) the butt welding of rails; in the last two cases heat is supplied by means of the oxy-acetylene flame.

The Welding of Non-Ferrous Metals, by E. G. West. (*Sheet Metal Industries, May*, 1945, *Vol.* 21, *No.* 217, *p.* 871, 14 *figs.*)

Part IV continued. Summary of gas welding processes, covering manipulation and procedure

Oxygen Machine Cutting in Industry, by L. J. Hancock. (*The Machinist*, 12*th and* 19*th May*, 1945, *Vol.* 89, *Nos.* 5 *and* 6, *pp.* 161 *and* 193, 6 *figs.*)

Cutting steel with the oxygen jet is considered indispensable for many jobs. Its application to other jobs often shows decreased production time, lower

production costs, and savings in equipment outlay. Resulting savings are reflected in lower cost of final products with advantage ultimately accruing to both management and workers. Such applications of machine flame cutting need careful planning to be successful. Planning factors are given. Manufacture of many fabricated products is speeded through the use of flame cutting. Data are given on typical jobs.

WELFARE.

Medical Service in Engineering Works. (*Machine Shop Magazine, May,* 1945, *Vol.* 6, *No.* 5, *p.* 58, 2 *figs.*)

This article outlines the duties of the industrial medical officer, and indicates his position relatively to others in the set-up of a firm. The suggestion is made that several small firms could get together as a group to employ one full-time medical officer rather than individual small firms should employ part-time officers.

INDEX TO ADVERTISEMENTS

As a war-time measure the advertisement section of this Journal is now published in two editions, A and B. Advertisers' announcements only appear in one edition each month, advertisements in edition A alternating with those in edition B the following month. This Index gives the page number and edition in which the advertisements appear for the current month.

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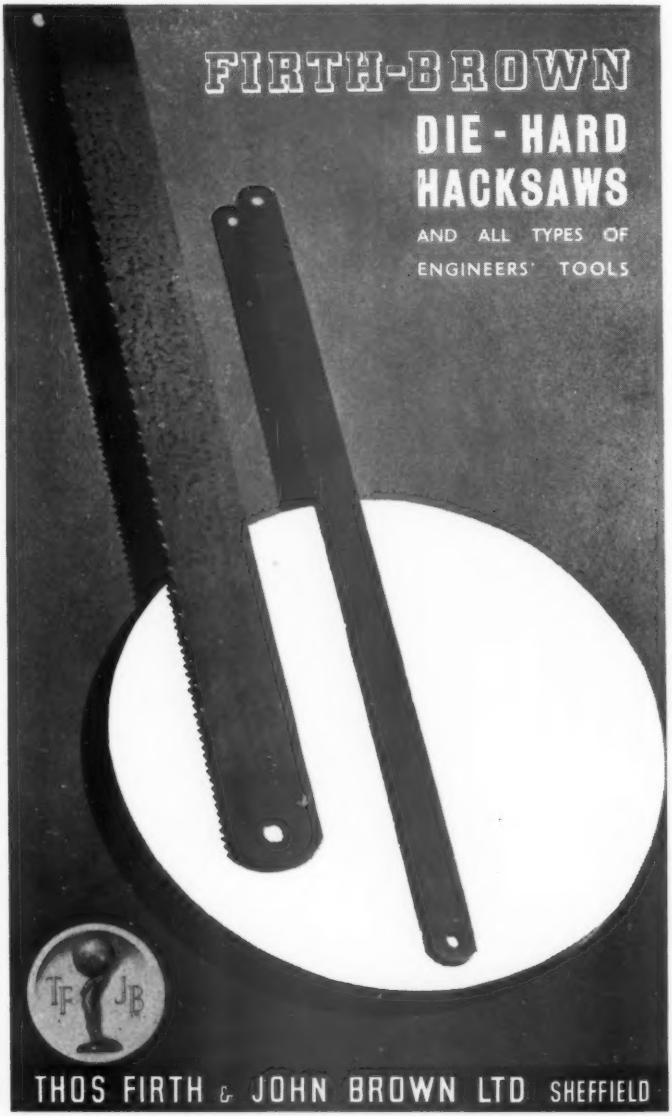
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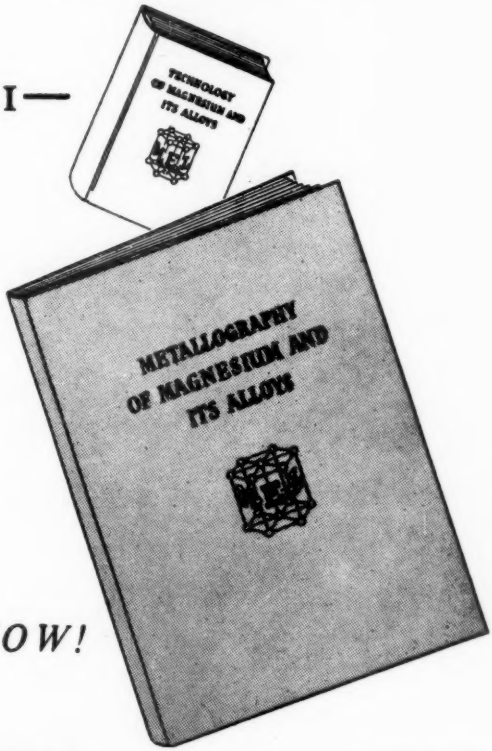

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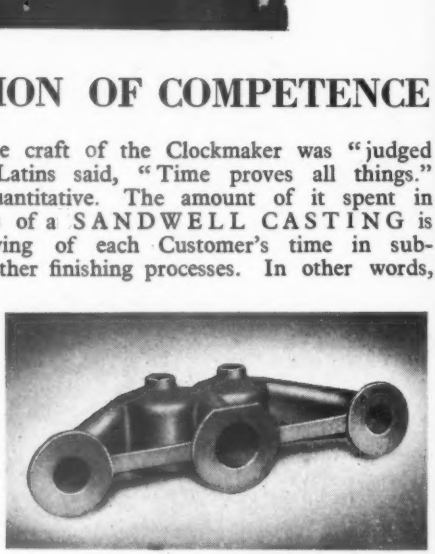

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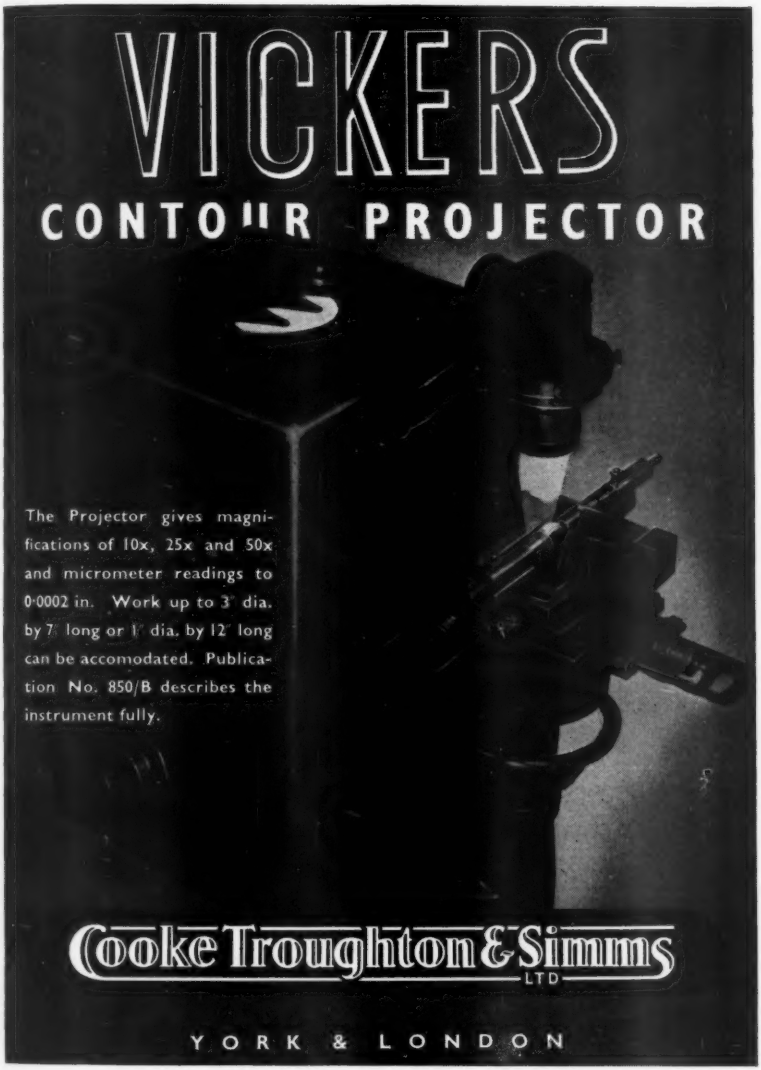

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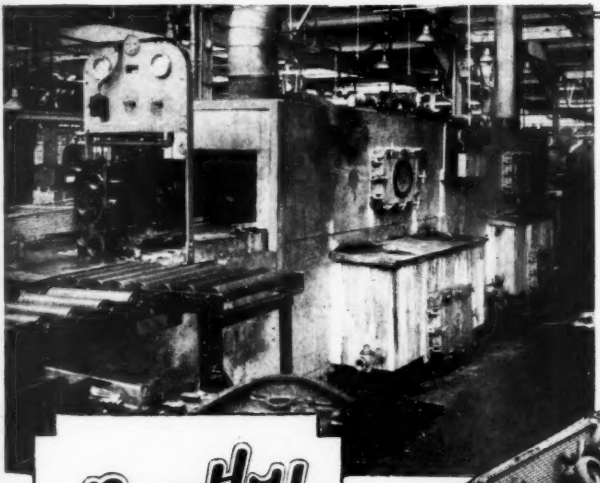

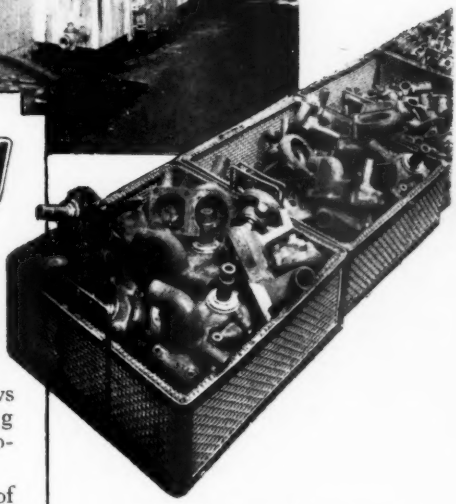

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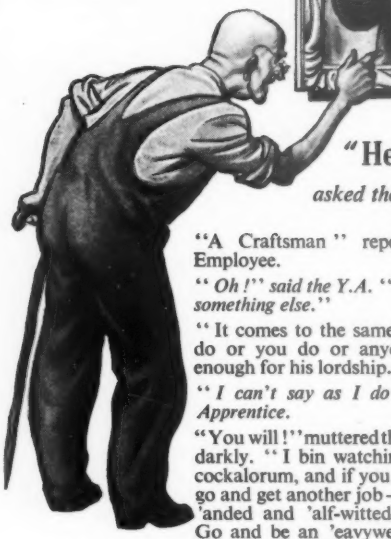

"He's a what?"

asked the Young Apprentice.

"A Craftsman" repeated the Oldest Employee.

"*Oh!*" *said the Y.A.* "*I thought you said something else.*"

"It comes to the same thing. Nothink I do or you do or anyone does is good enough for his lordship. See?"

"*I can't say as I do*" *said the Young Apprentice.*

"You will!" muttered the Oldest Employee darkly. "I bin watching you, me young cockalorum, and if you take my tip you'll go and get another job—where being 'am-'anded and 'alf-witted is an advantage. Go and be an 'eavyweight boxer. Get a job in one of these 'ere Ministries. You won't never do no good here."

"*Why not?*" *asked the Young Apprentice.*

"Because the Old Man's a Craftsman" said the Oldest Employee. "He ain't never satisfied with nothing and nobody. Not even me. I believe he 'ates 'isself! 'e'll certainly 'ate the very sight of you. 'E's a craftsman."

"*He certainly sounds like it!*" *said the Young Apprentice.*

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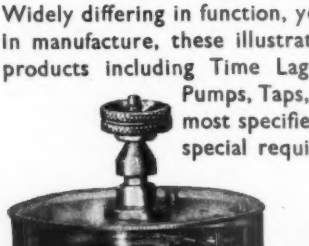

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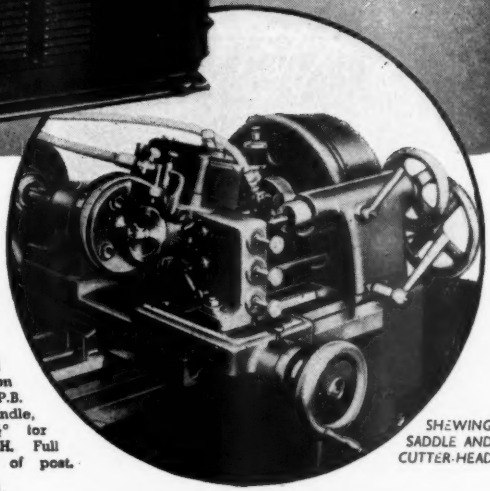

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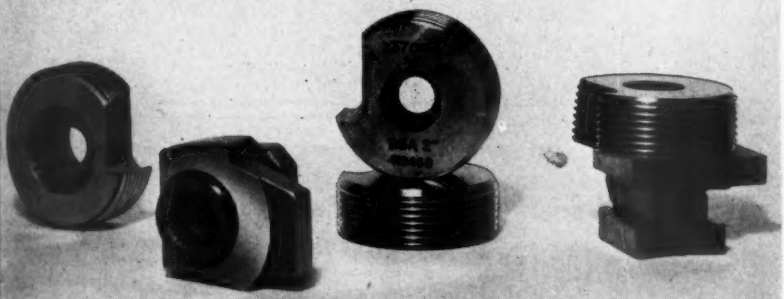

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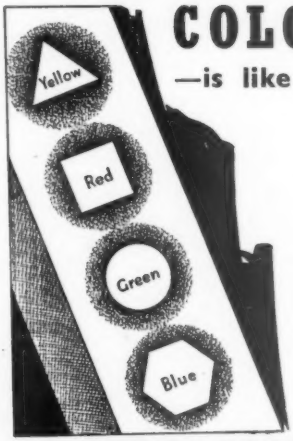
BURTON GRIFFITHS & CO. LTD. BIRMINGHAM, ENGLAND.

A MACHINE SHOP *without* COLOUR CONTROL

—is like a railway without signals!



Complicated setting by instruction plate wastes time, leads to mistakes. Supervision is equally difficult. With Murray Colour Control correct setting is shown by an unmistakable colour signal of distinctive shape. Setting, the work of a moment, is checked at a glance. The Murray system, standardised by leading tool manufacturers, is making a big contribution to present output. *Full particulars from :*

MURRAY COLOUR CONTROLS LTD.

STANHOPE HOUSE, KEAN ST., LONDON, W.C.2. TEMple Bar 8202

TAB MY.1.

THIS is the unit, complete in itself, with which to convert machine tools to individual motor drive. Simple design. Ball bearings throughout. Newman Totally Enclosed Motor with Push-button Operated Starter. Easy to instal and occupying small space. Gives increased efficiency, minimises maintenance and reduces costs of production. Quick delivery.

The **NEWMAN** *Motorised* **UNIT**

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The CLIMAX Pneumatic FETTLING GRIP saves time and money in Foundry and Fitting Shop. An air-operated vice holds the work dead firm for hand grinding, chipping, etc., without regard to shape of part. Write to-day for full specification.

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TAS/CX. 383

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THE COVENTRY SELF-OPENING DIEHEAD

12 SIZES ¼" TO 4½"

Cuts accurate threads in all materials that can be threaded. Simple to use, easy to set.

Dies quickly withdrawn for sharpening and replaced. Using the fixture all four dies of a set are sharpened at the same time to the correct cutting angles.

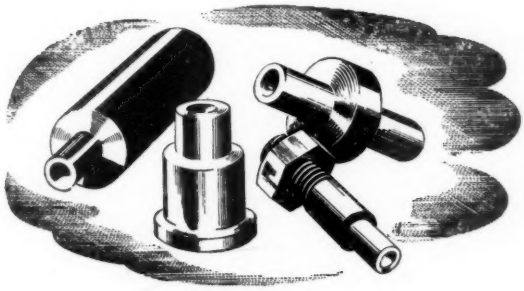
All sizes in stock.

ALFRED HERBERT LTD. COVENTRY

SPECIAL RESEARCH APPEAL

Will all Members and Affiliate Members who may still be considering Sir Robert McLean's letters of April 20th and May 7th, 1945, kindly reply to these communications at their earliest convenience, in order that the Research Fund can finally be adjusted to meet the demand of the interim period prior to the formation of the new British Production Engineering Research Association.

In step with production



An important feature of the NEW SOLVEX method is the way in which it degreases components quickly in batches, keeping step with production. There is no bottleneck or hold-up in the flow of parts while they are waiting to have cutting, tapping, or drawing compounds removed prior to the next operation.

A few minutes in the NEW SOLVEX bath, a rinse, and the batch is clean, ready for further processing.

New Solvex

METAL DEGREASING COMPOUND

On Air Ministry, Admiralty and War Office Lists
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World Pioneers

in the manufacture of

HEAT TREATED STEEL BOLTS

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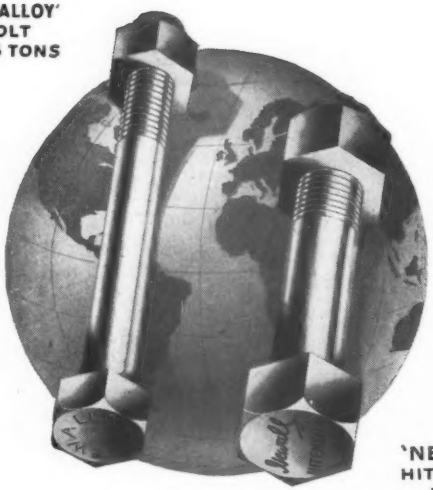

'NEWALL' HITENSILE BOLT 45-55 TONS

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